

PHYSICAL PROPERTIES OF CUSTARD APPLE FRUIT (*ANNONA SQUAMOSA L.*)

P. H. BAKANE¹, P. A. BORKAR², MADHURI GAJABE³ & MOHINI KHAKARE⁴

¹Associate Professor, Department of Agricultural Process Engineering, Dr. PDKV, Akola, Maharashtra, India

²Head, Department of Agricultural Process Engineering, Dr. PDKV, Akola, Maharashtra, India

³Junior Research Fellow, Department of Agricultural Process Engineering, Dr. PDKV, Akola, Maharashtra, India

⁴Project Assistant, Department of Agricultural Process Engineering, Dr. PDKV, Akola, Maharashtra, India

ABSTRACT

The physical properties custard apple fruits (*Annonasquamosa*) of balnagar variety obtained from the farmer's field were determined. These property included fresh fruit weight, size, arithmetic mean diameter, sphericity, surface area, true density, seeded pulp content, deseeded pulp content, peel content, number of seeds per fruit and volume of custard apple fruit varied in the ranged of 114.8 to 231.64 g, 58.92 to 74.15 mm, 57.41 to 76.80mm, 0.92 to 1.00, 109.02 to 172.66 cm², 0.74 to 1.7 g/cc, 37.06 to 67.11 %, 32.17 to 50.99 %, 32.89 to 62.94%, 3.27 to 22.84 % and 100 to 220 cm³, respectively. This study showed considerable variation in some physical properties of custard apple fruit. These properties can be useful for design of process equipment for custard apple.

KEYWORDS: Physical Properties Custard Apple Fruits (*Annonasquamosa*)

INTRODUCTION

In dryland areas, custard apple (*Annonasquamosa L.*) has occupied a unique place due to hardy nature for biotic and abiotic stresses, which belongs to the family Annonaceae, and have a native of tropical America. The fruit is heart shape weighing about 150 g with very bumpy skin. The black seeds are surrounded by white, creamy pulp which is very sweet and pleasantly flavored. The custard apple is mostly used as a dessert fruit for its delicious taste and nutritive values. The pulp is used in preparation of ice-cream and beverages (Chikhalikar, *et al.* 2000). Custard apple fruit is excellent source of carbohydrates, minerals, and protein. It is also a good source of vitamin A and C.

Generally, the fruit is grown on hills and barren land and farmers used to collect the fruit from these plants and sell them in the market. The demand for custard apple started growing in last few years and some dishes like '*Sitaphalrabdi*' and '*sitaphal* ice-cream' gained tremendous popularity. Therefore, the demand for the fruit has been increased and many farmers decided to cultivate the fruit. The production of custard apple in India for the year 2012-13 was 1,35,640 MT from an area of 19,550 ha. (Anonymous, 2012).

As the main season of harvesting the fruits is very short (October to November), there is usually glut leading to wastage and distress sale. Storage of the fresh fruits has limitations, since it is perishable, and cold storage is not promising because of the development of unattractive brown colour on the skin which decreases market value (Purohit, 1995). The custard apple pulp can be stored upto 3 months (Pardedede, 1994). The good quality graded fruits are sold at higher prices in market as compared to the relatively small size fruits, though small size fruits yields good quality of pulp.

Physical specification of agricultural products constitute the most important parameters needed in the design of grading, transfer, processing, and packaging systems. Physical specification of agricultural products mass, volume and center of gravity are of high importance in sizing system (Sawat and Moustafa, 1971). Parameters measurable through sizing system are dimensions (length, width, height), surface area and weight (Khojastehpour.1996).However, information on above aspect of custard apple is scanty, therefore, present experiment was undertaken to study the physical properties of custard apple fruit.

MATERIALS AND METHODS

Raw Material

Custard apple fruits (*Annonasquamosa*) of balnagar variety were procured from the farmer's field. Randomly selected 50 fruit were taken as study sample. The critical stage of harvesting was judged from the gap and colour between aerols on the surface.

Physical Properties of Custard Apple Fruit

Weight

Weight (g) of custard apple fruit was measured using an electronic balance with an accuracy of 0.01g.

Axial Dimensions

Three principal axes (length, breadth and thickness) of the fruit were measured with the help of Vernier calliper (Mitutoyo, Japan) having a least count of 0.02 mm.

Size

The size of fruit was calculated by using following formula.

$$\text{Size } (D_g) = (L \times B \times T)^{1/3} \quad (1)$$

Where,

L= Major axial dimension, mm.

B= Intermediate axial dimension, mm.

T= Minor axial dimension, mm

Arithmetic Mean Diameter

Arithmetic mean diameter (D_a) for each custard apple fruit were calculated using following equation (Mohsenin 1986).

$$D_a = \frac{(L \times B \times T)}{3} \quad (2)$$

Sphericity

The sphericity(Φ) of fruits was calculated using following formula.

$$\Phi = \frac{(L \times B \times T)^{1/3}}{L} \quad (3)$$

Surface Area

The surface area of custard apple fruit were calculated by using following formula. (Topuz, 2004).

$$S = \pi \times D_g^2 \quad (4)$$

Where,

S = Surface area, mm^2 .

D_g = Geometric mean diameter mm.

Volume of Fruit

Fruit volumes were measured by water displacement method. Fruits were weighed in air and allowed to float in water. Fruits were lowered with needle into a graduated beaker containing water and mass of water displaced by the individual fruit was recorded.

$$\text{Volume}(\text{cm}^3) = \frac{\text{weight of displaced water (g)}}{\text{weight density of water } (\frac{\text{g}}{\text{cm}^3})} \quad (5)$$

True Density of Fruits

True density of fruit of was calculated using following equation (Mohsenin,1986)

$$\text{True density } (\text{g/cm}^3) = \frac{\text{FruitMass (g)}}{\text{FruitVolume } (\text{cm}^3)} \quad (6)$$

Colour of Fruits

Colour of custard apple fruit was determined by Minolta chromameter (CR-400) in terms of L, a, b value.

Seeded Pulp Content

Custard apple pulp scooped manually and weight of seeded pulp recorded. Seeded pulp content of custard apple was calculated by using formula given by (Kolekar and Tagad 2012). Seeded pulp is shown in Plate 3.

$$\text{Seeded pulp content \%} = \frac{W_{SP}}{W_F} \times 100 \quad (7)$$

Where,

W_{SP} = Weight of seeded pulp, g

W_F = Weight of fruit, g



Plate 1: Seeded Custard Apple Pulp

Peel Content

Peel content of custard apple was calculated by using following formula: (Kolekar and Tagad 2012)

$$\text{Peel content \%} = \frac{W_P}{W_F} \times 100 \quad (8)$$

Where,

W_P = Weight of peel, g

W_F = Weight of fruit, g



Plate 2: Peel of Custard Apple Fruits

De-Seeded Pulp Content

De-seeded pulp content of custard apple was calculated by using formula given by (Kolekar and Tagad, 2012). Deseeded pulp is shown in Plate 4.

$$\text{De-seeded pulp content \%} = \frac{W_{DP}}{W_F} \times 100 \quad (9)$$

Where,

W_{DP} = Weight of de-seeded pulp, g

W_F = Weight of fruit, g



Plate 3: De-Seeded Custard Apple Pulp

Seed Content

Seeds from the custard apple pulp were separated manually and weight of seed per fruit were recorded. Seed content of custard apple was calculated by using formula given by (Kolekar and Tagad 2012)

$$\text{Seed content \%} = \frac{W_S}{W_F} \times 100 \quad (10)$$

Where,

W_S = Weight of seed, g

W_F = Weight of fruit, g

Number of Seeds

Seeds of custard apple were separated from the each fruit and counted manually.



Plate 4: Custard Apple Seeds

Number of Flakes

Number of flakes present in a fruits were separated and counted manually.



Plate 5: Number of Flakes

Custard apple flakes as shown in Plate 2 is important from the market point of view. Custard apple seeds are surrounded by these flakes. Therefore, these flakes were separated and counted manually.

Statistical Analysis

Basis statistic of physical properties of custard apple fruit were carried out using software available on website www.icargoa.res.in.

RESULT AND DISCUSSIONS

Physical Properties of Custard Apple Fruit

Weight of Fruit

The weights of corresponding 50 fruits were recorded with the help of electronic balance with least count 0.01 g. The average weight of fruits was found to be 155.02 g. The maximum and minimum weight of fruit was to be 231.64 and 114.8 g, respectively (Table 1). The average weight of fruits was found to be 155.02 g with standard deviation 27.38.

Size of Fruit

The size of custard apple fruits were determined from the measurement of its axial dimensions *i.e.* length, width and thickness and results are summarized in Table 1. The observed size of fruits was found to vary in the range of 58.92 to 74.15 mm. The average size of fruits was found to be 66.15 mm with standard deviation 4.12.

Arithmetic Mean Diameter

Arithmetic mean diameter of custard apple fruits was calculated from its axial dimensions. The maximum value of arithmetic mean diameter was found to be 76.80 and minimum value was found to be 57.41 as depicted in Table 1. An average value of arithmetic mean diameter was found to be 66.20 mm with standard deviation 4.85.

Table 1: Variation in Weight, Axial Dimensions, Size and Arithmetic Mean Diameter Custard Apple Fruits

Particular	Weight of Fruit, G	Axial Dimensions, Mm			Size Mm,	Arithmetic Mean Diameter, Mm
		L	B	T		
Max	231.64	78.19	76.9	76.80	74.15	76.80
Min	114.8	57.18	56.38	57.41	58.92	57.41
Avg	155.02	66.23	66.23	66.20	66.15	66.20
SD	27.38	5.05	4.89	4.85	4.12	4.85
Var	749.67	25.58	23.91	23.58	17.02	23.58
SEM	3.87	0.715	0.69	0.69	0.58	0.69
CV, %	17.66	7.63	7.38	7.33	6.23	7.33

Sphericity

The sphericity of custard apple fruits was determined with the help of mathematical equation summarised results are given in Table 2. The maximum value of sphericity was found to 1 and minimum was found to be 0.92 with an average of 0.96. This shows that custard apple fruit of are near to spherical. This property may be used for design of fruit grader.

Table 2: Variation in Sphericity, Surface Area, Volume, Ture Density and Colour of Custard Apple Fruits

Particulars	Sphericity	Surface Area, Cm ²	Volume Cm ³	True Density, G/Cc	Colour		
					L	A	B
Max	1.00	172.66	220	1.7	56.84	0.27	30.59
Min	0.92	109.02	100	0.74	36.47	-8.91	10.99
Avg	0.96	137.96	150.7	1.04	45.75	-4.81	21.35
SD	0.025	17.38	27.16	0.148	5.21	2.38	4.09
Var	0.001	302.08	737.65	0.022	27.14	5.68	16.79
SEM	0.004	2.46	3.84	0.021	0.73	0.33	0.58
CV	2.56	12.59	18.02	14.28	11.38	-49.58	19.18

Surface Area

The surface area of custard apple was calculated with the help of mathematical equation and results are summarised in Table 2. The maximum value of surface area of custard apple fruits was found to be 232.84 mm² and minimum area was found to be 85.02 mm². The average surface area of custard apple fruit was found to be 207.73 mm² with 12.95 mm² standard deviation.

Volume of Fruit

The volume of fruits was determined by the water displacement method. The volume of custard apple fruits was found to be in the range of 110 to 220 cm³. The average volume of fruits was recorded 150.7 cm³ with standard deviation 27.16 cm³.

True Density

True density of custard apple fruits was determined by using equation number 6. The maximum and minimum true density of fruits was found to be 1.7 and 0.74 g/cc, respectively. The average true density were found to be 1.04g/cc with standard deviation 0.148 g/cc.

Colour of fruits

Colour of 50 custard apple fruits were measured in terms of L, a, b value with help of chromameter (CR-400). The maximum value of L, a and b was found to be 56.84, 0.27 and 30.59, respectively, and minimum value of L, a and b were found to be 36.47, 8.91 and 10.99, respectively.

Table 3: Variation in Weight of Seeded Pulp, Peel, De-Seeded Pulp and Number of Flakes of Custard Apple

Particular	Weight of Seeded Pulp (G)	Weight of Peel (G)	Weight of De-Seeded Pulp (G)	Number of Flakes Without Seeds	Number of Flakes With Seeds	Total Number of Flakes
Max	133.83	119.88	103.8	64	89	106
Min	28.53	37.76	23.07	12	8	42
Avg	72.79	67.76	57.16	32.56	40.06	72.62
SD	20.79	15.43	15.86	11.95	18.15	12.87
Var	432.47	238.11	251.83	142.94	329.56	165.79
SEM	2.94	2.18	2.24	1.69	2.56	1.82
CV	28.56	22.77	27.75	36.72	45.31	17.73

Weight of Seeded Pulp

Weight of seeded pulp per fruit was recorded with the help of electronic balance. The summarized data presented in Table 3 indicates that the maximum and minimum weight of seeded pulp was found to be 133.83 g and 28.53 g, respectively. The average weight of seeded pulp was found to be 72.79 g.

Weight of Peel

The data presented in Table 3 shows that maximum and minimum weight of peel of custard apple fruit was found to be 119.88 and 37.76 g respectively, with average weight 67.76 g.

Weight of De-Seeded Pulp

Weight of deseeded pulp was recorded with weighing balance of least count 0.01g after separating the peel and seeds from the pulp manually. The data presented in Table 3 shows that maximum and minimum weight of de-seeded pulp was 103.8 g and 23.07 g, respectively, and average weight of pulp was found to be 57.16 g.

Number of Seeds

Seeds of custard apple were separated manually from the pulp. Each seed of the custard apple was found to be covered with the flakes. These flakes were also separated from the seeds. The data presented in Table 3 shows the maximum and minimum number of seeds per fruit was found to be 89 and 8, respectively with average number of seeds 40.06.

Number of Flakes

Flakes of custard apple were separated from the pulp and counted manually. The data of flakes presented in Table 3 shows that maximum and minimum number of total flakes present in the custard apple fruit was found to be 106 and 42, respectively with average of 72.62.

Table 4: Variation in Percentage of Peel, Seeded Pulp, De-Seeded Pulp and Seeds of Custard Apple Fruit

Particular	Peel Content, %	Seeded Pulp Content, %	De-Seeded Pulp Content, %	Seed Content, %
Max	62.94	67.11	50.99	22.84
Min	32.89	37.06	32.17	3.27
Avg	48.62	51.37	40.38	10.30
SD	7.05	7.05	4.64	4.01
Var	49.72	49.72	21.55	16.11
SEM	0.99	0.99	0.65	0.56
CV, %	14.50	13.72	11.49	38.95

Peel Content

Data of percent peel of corresponding 50 fruits summarised data are given in Table 4. Peel of custard apple fruits was separated manually and per cent peel was calculated by equation. The maximum and minimum per cent of peel was recorded 62.94 and 32.89 per cent respectively, while average percent of peel was recorded 48.62 per cent.

Seeded Pulp Content

Pulp with seeds was scooped from the custard apple fruit and per cent seeded pulp content was calculated. The data presented in Table 4 shows that the maximum and minimum per cent seeded pulp content were 67.11 and 37.06, respectively. The average seeded pulp content was found to be 51.37 per cent.

De-Seeded Pulp Content

After scooping the pulp from the fruits seeds were separated. The de-seeded pulp content was calculated. The maximum and minimum percentage of de-seeded pulp content in the fruit was found to be 50.99 and 32.17, respectively with an average 40.38 % of the fruit.

The similar results were also reported by Beerh (1983), Hashmi and Pawar (2011), Bhatnagar (2012) and Kolekar and Tagad (2012).

Seed Content

The seeds present in the fruits were separated manually and per cent seed was recorded. Summarised data are

given in Table 4. The average seed percent in the custard apple fruits was found to be 10.30 per cent with standard deviation 4.01 per cent.

CONCLUSIONS

This study showed considerable variation in some physical properties of custard apple fruit (Balalnagar variety). These properties can be useful for design of process equipment for custard apple. More studies of physical and chemical properties in relation among different cultivars need to be undertaken.

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